# Microliter Flow M.P.C.

## Modular Pumping Component

## User's Manual
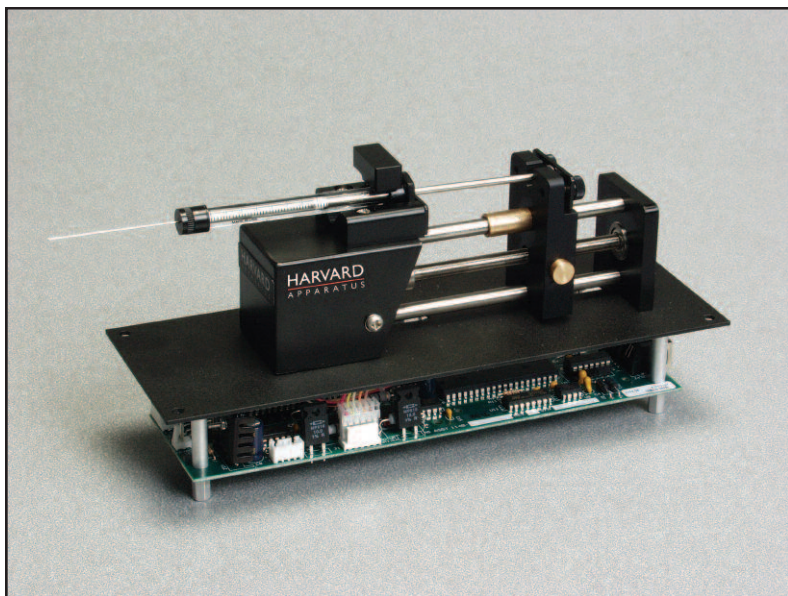
# HARVARD
## A P P A R A T U S

# WEEE/RoHS Compliance Statement

**EU Directives WEEE and RoHS**

To Our Valued Customers:

We are committed to being a good corporate citizen. As part of that commitment, we strive to maintain an environmentally conscious manufacturing operation. The European Union (EU) has enacted two Directives, the first on product recycling (Waste Electrical and Electronic Equipment, WEEE) and the second limiting the use of certain substances (Restriction on the use of Hazardous Substances, RoHS). Over time, these Directives will be implemented in the national laws of each EU Member State.

Once the final national regulations have been put into place, recycling will be offered for our products which are within the scope of the WEEE Directive. Products falling under the scope of the WEEE Directive available for sale after August 13, 2005 will be identified with a "wheelie bin" symbol.

Two Categories of products covered by the WEEE Directive are currently exempt from the RoHS Directive – Category 8, medical devices (with the exception of implanted or infected products) and Category 9, monitoring and control instruments. Most of our products fall into either Category 8 or 9 and are currently exempt from the RoHS Directive. We will continue to monitor the application of the RoHS Directive to its products and will comply with any changes as they apply.
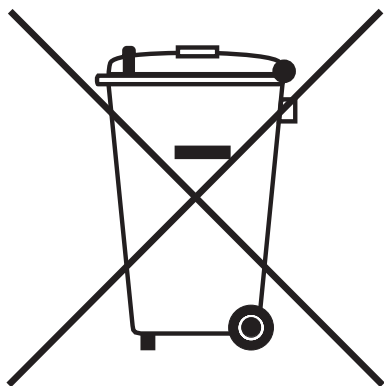
- **Do Not Dispose Product with Municipal Waste**
  - **Special Collection/Disposal Required**

# *Table of Contents*

*1*

Harvard Apparatus "µl" Modular Pumping Component

**SUBJECT**                                         **PAGE NO.**

# General Information

Harvard Apparatus "µl" Modular Pumping Component

### Serial Number

All inquires concerning our product should refer to the serial number of the unit. Serial numbers are located on the underside of the baseplate.

### Calibration

All syringe pumps are designed and manufactured to meet their performance specifications at all rated voltages and frequencies.

### Warranty

Harvard Apparatus warranties this instrument for a period of two years from date of purchase. At its option, Harvard Apparatus will repair or replace the unit if it is found to be defective as to workmanship or material.

This warranty does not extend to damage resulting from misuse, neglect or abuse, normal wear and tear, or accident.

This warranty extends only to the original customer purchaser.

**IN NO EVENT SHALL HARVARD APPARATUS BE LIABLE FOR INCI-DENTAL OR CONSEQUENTIAL DAMAGES**. Some states do not allow exclusion or limitation of incidental or consequential damages so the above limitation or exclusion may not apply to you. **THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR USE, OR OF ANY OTHER NATURE**. Some states do not allow this limitation on an implied warranty, so the above limitation may not apply to you.

If a defect arises within the two-year warranty period, promptly contact your local distributor or ***Harvard Apparatus, Inc. 84 October Hill Road Holliston, Massachusetts 01746-1388*** using our toll free number 1-800-272-2775 (valid only in the U.S., outside U.S. call 508-893-8999). Goods will not be accepted for return unless an RMA (returned materials authorization) number has been issued by our customer service department. The customer is responsible for shipping charges. Please allow a reasonable period of time for completion of repairs, replacement and return. If the unit is replaced, the replacement unit is covered only for the remainder of the original warranty period dating from the purchase of the original device.

This warranty gives you specific rights, and you may also have other rights which vary from state to state.

### Repair Facilities and Parts

Harvard Apparatus stocks replacement and repair parts. When ordering, please describe parts as completely as possible, preferably using our part numbers. If practical, enclose a sample or drawing. We offer a complete reconditioning service.

```
CAUTION
FOR RESEARCH USE ONLY
NOT FOR CLINICAL
USE ON PATIENTS
```

### CAUTION

This pump is not registered with the FDA and is not for clinical use on human or veterinary patients. It is intended for research use only.

# *General Safety Summary*

Please read the following safety precautions to ensure proper use of your modular syringe pump. To avoid potential hazards and product damage, use this product only as instructed in this manual. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

## *To Prevent Hazard or Injury:*

### Use Appropriate Power Supply

Use only an SELV approved power supply. Be sure to observe proper polarity of connections when hooking up DC supply voltage.

> CAUTION:  FAILURE TO MAINTAIN POLARITY MAY RESULT IN DAMAGE
>                   TO THE UNIT AND WILL VOID THE WARRANTY.
>
>                   12 Vdc return–PINS 1 & 2 of connector J7
>                   12 Vdc positive–PINS 3 & 4 of connector J7

(see input connections diagram, page #6)

### Ground the Product

This product is grounded through a ground stud located on the under side of the base plate. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making any connections to the input or output terminals of the product, ensure that the product is properly grounded.

### Make Proper Connections

Make sure all connections are made properly and securely. Any signal wire connections to the unit must be no longer than 3 meters.

### Avoid Contact with Heatsinks:

Some components normally operate at temperatures exceeding 70 deg C. To avoid injury, do not touch any heatsinks.

### Observe all Terminal Ratings

Review the operating manual to learn the ratings on all connections.

### Avoid Exposed Circuitry

Do not touch any electronic circuitry.

### Do Not Operate with Suspected Failures

If damage is suspected on or to the product do not operate the product. Contact qualified service personnel to perform inspection.

### Avoid Liquid Spills

The Microliter Pump has openings in the baseplate to accomodate limit switches. Care should be taken to avoid spills that could allow liquid to get onto the circuit board.

# *General Safety Summary*

## Place Product in Proper Environment

Enviromental Conditions:
- - Indoor use only
- - Temperature 4˚C to  40˚C (40˚F to 104˚F)
- - Humidity 20% to 80% RH
- - Well Ventilated Room
- - Altitude up to 2000 m
- - Voltage Fluctuation not to Exceed +/- 10% of Nominal
- - Transient Overvoltage Category II
- - Pump is Rated Pollution Degree 2 in Accordance with IEC 664

## Observe all Warning Labels on Product

Read all labels on product to ensure proper usage.



*CAUTION*
   *Refer to Manual*



*Protective Ground Terminal*



*Pinch Hazard*



*Caution:*
   *Hot*
      *Surface*



*Caution:*
*ESD Sensitive Device*

# *Introduction*

## Theory of Operation:

The new "μl" Modular Pumping Component is a low cost, highly precise, single syringe infuse/withdraw pump module capable of low to moderate back pressures. The module includes a mechanism, hardware and software and requires the addition of a power supply and user interface.

The pump comes in one version and will hold one syringe of any make from 0.5 μl to 1ml. The diameter of the syringe(s) is entered via the RS-232 serial port, and the internal microprocessor drives a precision stepper motor to produce accurate fluid flow. This unit is designed to operate inside an appropriately rated fire/electrical/mechanical enclosure or cabinet. The board may be removed for "remote" operation.

## Features:

### *Two Modes of Operation, Constant Flow Rate and Volume Dispense*

The "μl" Modular Pumping Component will operate continuously in RATE mode or accurately dispense a specific amount of fluid in VOLUME mode. When starting the pump, RATE mode will be the default mode. To operate in VOLUME mode, set a target volume and the pump will change modes to suit desired operation.

### *Smooth Flow*

New micro-stepping pump profiles deliver very smooth and consistent flow.

### *Nonvolatile Memory*

The pump remembers it's last syringe size, flow rate used and configuration settings in it's non-volatile memory.
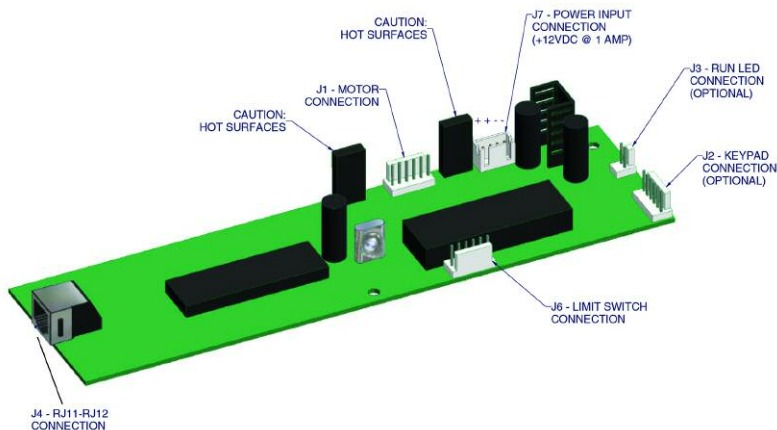
### *CE Mark Approved*

The "μl" Modular Pump meets all relevant european safety requirements for laboratory equipment when used in accordance with the guidelines in this manual.

Harvard Apparatus "µl" Modular Pumping Component



**Defaults Settings:**

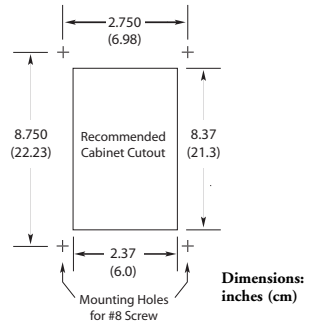| | | |
|---|---|---|
| **Dia:** 4.61mm=1ml | **Rate:** 1.0ml/hr. | **Baud:** 9600 |
| **Address:** 00 | **Mode:** Pump | |

# What's included:

## Packaged with the "µl" Modular Pumping Component:

- (1) 6 ft. DC power cable extension cable - 1143-209
- (1) 6 ft. Motor/limit switch extension cable - 1143-211
- (1) RS-232 cable - 70-2022
- (1) User documentation
- (1) 6 oz. jar of grease
- (1) Syringe pump unit

# *Installation*

## Location Requirements for the Syringe Pump

- A sturdy, level, clean and dry surface

- Minimum of one inch (2cm) clearance around the pump

- Appopriate environmental conditions

- A well ventilated room

- Mount into an appropriately rated enclosure or cabinet

2.750 (6.98)

8.750 (22.23)    Recommended Cabinet Cutout    8.37 (21.3)

2.37 (6.0)

Mounting Holes for #8 Screw

**Dimensions: inches (cm)**

## Loading the Syringe

1. Release the Syringe pusher block (4) by pressing the bronze button (3) on the side of the pusher.

2. While holding the bronze button 'in', slide the pusher to the right.

3. Raise the spring loaded syringe retainer (1) and swing it out of the way.

4. Lay the loaded syringe in the 'V' shaped holder.

5. Swing the retainer so it holds the syringe in place.

6. Move the pusher so it makes contact with the syringe plunger.

7. Adjust pusher block Thumbscrews & bracket (2) until the syringe plunger is completely captured.

8. The limit switches can be easily adjusted by loosening the #2 nuts (not shown), sliding the switch to desired position, and retightening the nuts into place.
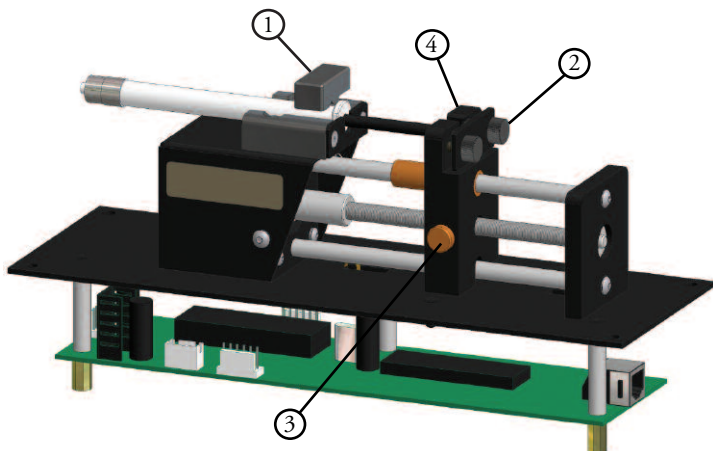
# *Operation*

<u>*Getting started*</u>

Plug one end of the 6 ft. power cable supplied into (J7) connection on board. Then plug the other end of the power cable into your power supply (not included). Be sure to maintain proper polarity of connection so as not to damage the unit. Plug the RS-232 cable supplied into J4 connection and your PC.

Note: Refer to page 6 of this manual to reference the board connections.

## *Working with the pump*
The safest way to use the "µl" Modular Pumping Component is in the volume dispense mode. The pump will automatically stop when target volume is dispensed.

## *Check  Syringe Often*
Limit switches are incorporated onto the "µl" Modular Pumping Component to stop the pump at the end of limit travel for infusion and withdraw. Be sure to adjust and set these switches properly to prevent damage to small fragile syringes.

## *Maintenance*
Keep the "µl" Modular Pumping Component clean and dry.  Avoid liquid spills that may find their way into the electronics.

A small container of grease is provided for periodic lubrication of the lead screw.  It is important to keep the leadscrew clean and lubricated.

To clean the exterior surfaces above the baseplate, use a lint-free cloth to remove loose dust. For more efficient cleaning, use a soft cloth dampened with water or an aqueous solution of 75% isopropyl alcohol. Do not allow fluid to pass through the holes in the baseplate and get onto the electronics.

If the pump does not work properly, contact Harvard Apparatus for appropriate instructions.

# HYPER-TERMINAL: *Terminal Emulation Software*

## *Remote Control Via The RS-232 Interface Using HYPERTERMINAL\**

\* Normally included with most Windows® operating systems.

**"µl" Modular Pumping Component**

1. *Connect the RS-232 cable (supplied) between the "µl" Modular Pumping Component RS-232 IN port and a PC's serial port.*

2. *On the PC (running a Microsoft Windows Operating System), select START – PROGRAMS – ACCESSORIES – HYPERTERMINAL – HYPERTERMINAL to start the Hyperterminal application. If Hyperterminal is not available, install it from the Microsoft Windows Operating System Install disks or CD ROM.*

3. *Set up the appropriate COMPORT for the following:*
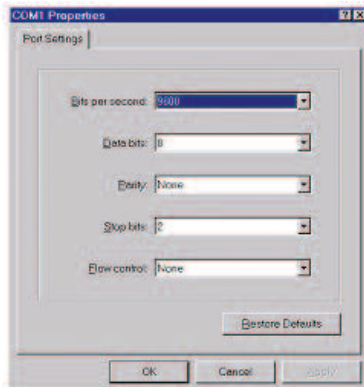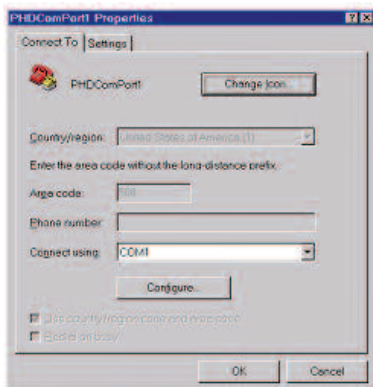
**Configure:**

| | |
|---|---|
| Baud Rate : | 9600 |
| Data Bits: | 8 |
| Parity: | None |
| Stop Bits: | 2 |
| Flow Cntrl: | None |
| Emulation: | Auto Detect |

**ASCII Setup:**

Echo typed characters locally.
Line delay: 0
Character delay: 0
Wrap lines.
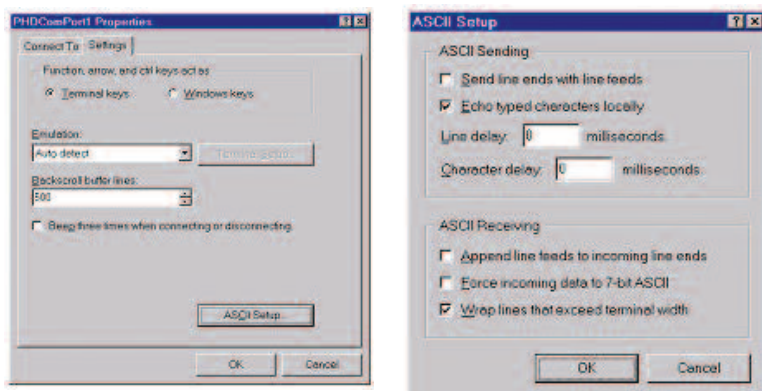
You may want to save the setup information under a
descriptive filename.

4. *At the PC, launch hyperterminal with the above setup specifications (if it is not already running). Type **VER** at the PC keyboard and verify that the pump module's version is displayed at the PC terminal.*

5. Type **RUN** to start the pump; type **STP** to stop the pump. After starting the pump, **0>** should be displayed, indicating address 0 pump is infusing. After stopping the pump, **0\*** should be displayed.

# *Appendix A*

## OEM 'µl' Module Specifications

| | |
|---|---|
| **Type** | Microprocessor single syringe, infusion/withdraw |
| **Syringe/Size for OEM µl Pump:** | |
|     **with Holder For** | Glass or Plastic |
|     **1 Syringe** | From 0.5 µL (min.) to 1 mL (max) |
| **Flow Rate Range:** | |
|     **Flow rate (Min / Max)** | 0.0014 µl/hr with 0.5 µl syringe / .854 ml/min with 1 ml syringe |
| **Linear Force:** | 7 lb (max) |
| **Display:** | None |
| **Keypad:** | None |
| **Interface:** | RS-232 |
| **Limit Switch:** | One for each direction (end of travel) |
| **Drive:** | Motor: 0.9° step angle motor |
| | Control: L/R Drive, 0.75A per phase, 1/4 stepping |
| | Drive Ratio: 1:1 (Direct Drive) |
| | Lead screw pitch: 48 threads per inch (1/4-48) |
| **Step Rate:** | 6.8 sec./step - 416.7 µl/step |
| **Pusher Travel Rate:** | 2.9 µm/min / 47.6 mm/min (Min/Max) |
| **Connectors:** | RS-232: RJ-11 telephone jack |
| | DC Power: 4-pin Header (Friction lock) |
| **Power:** | +12VDC, 5%, 1A (12W) |
| | Note: Use only a SELV approved power supply |
| **Size, H x W x D:** | 9.25" x 3.25" x 4.50" (L x W x H) |
| | 23.5cm x 8.3cm x 11.4cm |
| **Mounting Dimmensions:** | 8.75" x 2.75" (Mounting holes for (4) #8 screws) |
| | 22.2cm x 7.0cm |
| **Weight:** | 1.85 lbs (0.84 kg) |
| **Enviromental:** | Operating Temp: 0 to +35 deg. C (natural convection cooling) |
| | Storage Temp: -20 to +70 deg. C |
| | Humidity: 20% to 80% RH non-condensing |

*\*\* Note: operating temperature may be extended with forced air cooling*

Harvard Apparatus "µl" Modular Pumping Component

### Unimetrics
### Series 4000 & 5000

| Size | Diameter |
|------|----------|
| 10 µl | 0.460 mm |
| 25 | 0.729 |
| 50 | 1.031 |
| 100 | 1.460 |
| 250 | 2.300 |
| 500 | 3.260 |
| 1000 | 4.610 |

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### SGE
### Scientific Glass
### Engineering

| Size | Diameter |
|------|----------|
| 25 µl | 0.73 mm |
| 50 | 1.03 |
| 100 | 1.46 |
| 250 | 2.30 |
| 500 | 3.26 |
| 1000 | 4.610 |

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### Hamilton–Microliter
### Series Gastight

| Size | Diameter |
|------|----------|
| .5 µl | 0.103 mm |
| 1 | 0.1457 |
| 2 | 0.206 |
| 5 | 0.3257 |
| 10 | 0.460 |
| 25 | 0.729 |
| 50 | 1.031 |
| 100 | 1.46 |
| 250 | 2.3 |
| 500 | 3.26 |
| 1000 | 4.610 |

# Appendix C: Flow Rates

| nominal syringe size | nominal diameter (mm) | μl/hr | | μl/min | | ml/hr | | ml/min | |
|---|---|---|---|---|---|---|---|---|---|
| | | min | max | min | max | min | max | min | max |
| Min | **0.10** | 0.0014 | 22.35 | 0.0001 | 0.3725 | 0.0001 | 0.0223 | 0.0001 | 0.0003 |
| 1 μl | **0.15** | 0.0031 | 50.29 | 0.0001 | 0.8383 | 0.0001 | 0.0502 | 0.0001 | 0.0008 |
| 2 μl | **0.21** | 0.0061 | 98.58 | 0.0002 | 1.6430 | 0.0001 | 0.0985 | 0.0001 | 0.0016 |
| 5 μl | **0.33** | 0.0149 | 243.4 | 0.0003 | 4.057 | 0.0001 | 0.2434 | 0.0001 | 0.0040 |
| 10 μl | **0.46** | 0.0289 | 473.0 | 0.0005 | 7.883 | 0.0001 | 0.4730 | 0.0001 | 0.0078 |
| 25 μl | **0.73** | 0.0728 | 1,191 | 0.0013 | 19.85 | 0.0001 | 1.191 | 0.0001 | 0.0198 |
| 50 μl | **1.03** | 0.1448 | 2,371 | 0.0025 | 39.52 | 0.0002 | 2.371 | 0.0001 | 0.0395 |
| 100 μl | **1.46** | 0.2909 | 4,765 | 0.0049 | 79.41 | 0.0003 | 4.765 | 0.0001 | 0.0794 |
| 250 μl | **2.30** | 0.7218 | 9,999 | 0.0121 | 197.0 | 0.0008 | 11.82 | 0.0001 | 0.1970 |
| 1,000 μl | **3.26** | 1.451 | 9,999 | 0.0242 | 395.7 | 0.0015 | 23.75 | 0.0001 | 0.3959 |
| 1 ml | **4.61** | 2.900 | 9,999 | 0.0484 | 791.8 | 0.0029 | 47.50 | 0.0001 | 0.7918 |
| **Max** | **35.00** | **167.2** | **9,999** | **2.786** | **9,999** | **0.1672** | **2,738** | **0.0028** | **45.64** |

# Appendix D: Serial Communication

Harvard Apparatus "µl" Modular Pumping Component

## Commands, Queries and Responses

After each transmission to the pump terminating with a CR character (ASCII 13), the pump enters remote mode and responds with the three character sequence:

| CR | LF | ***prompt*** |
|----|----|--------------|

The prompt character indicates the status of the pump as follows:

| ***prompt*** | meaning | ASCII code |
|------|---------|------------|
| : | When stopped | (ASCII 58 decimal) |
| > | When running forward | (ASCII 62 decimal) |
| * | When stalled | (ASCII 42 decimal) |
| | | This pump does not include stall detection |

## Serial commands and their meanings:

### *Commands:*

| | |
|----|----|
| **KEY** | Return to keyboard control.  Exit remote mode |
| **RUN** | Start infuse (forward direction) |
| **STP** | Stop motor |
| **CLV** | Clears volume accumulator to zero |
| **CLT** | Clears target volume to zero, dispense disabled |
| **REV** | Reverses pumping direction |

### *Commands with numbers:*

| | | |
|------|--------|-----|
| **MMD** | number | Set syringe diameter, units are mm. Rate is set to zero after MMD command. |
| **ULM** | number | Set flow rate and range, units are microliters per minute |
| **MLM** | number | Set flow rate and range, units are milliliters per minute |
| **ULH** | number | Set flow rate and range, units are microliters per hour |
| **MLH** | number | Set flow rate and range, units are milliliters per hour |
| **MLT** | number | Set target infusion volume, units are ml or µl depending on range |

**Numbers can be between 0 and 1999.**
Leading zeros and trailing decimal point are optional.  Any number of digits to the right of the decimal point may be transmitted. The number will be rounded.

**Queries:**

| | |
|---|---|
| **DIA** | Returns diameter value units in mm |
| **RAT** | Returns rate value set in current range units |
| **VOL** | Returns current accumulated infused volume, units in ml or µl depending on range |
| **VER** | Returns model and version number of firmware |
| **TAR** | Returns target volume, units in ml or µl depending on range |

**value format:  nnnn.nnn**
The returned value is an 8 character string with leading zeros converted to SP characters (ACSII 32 decimal).  The fifth character is a decimal point (ASCII 46 decimal)
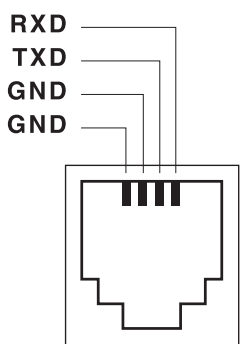
**Queries with string response:**

| | |
|---|---|
| **RNG** | Returns range message (character string either: ML/H  ML/M UL/H  UL/M) |

**Error responses:**

| | |
|---|---|
| **CR  LF ?  CR  LF  prompt** | Unrecognized command |
| **CR  LF  OOR  CR  LF  prompt** | Entered value in out of range |

# Appendix E: Single RS-232

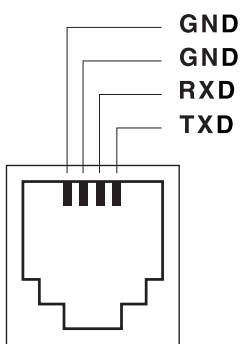RXD
TXD
GND
GND

**IN**

*Host*
*Computer*
*Connection*

# Appendix F: Dual RS-232 (optional)

RXD          GND
TXD          GND
GND          RXD
GND          TXD

**IN**          **OUT**

*Host*          *Chain*
*Computer*      *Connection to*
*Connection*      *Additional Pump(s)*

# Declaration of Conformity

Application of
  Council Directive(s):               *73/23/EEC*

Standard(s) to which
  conformity is declared:             *EN61010-1 (1993)+ A2 (1995)*

Manufacturer's Name:                  *Harvard Apparatus, Inc.*

Manufacturer's Address:               *84 October Hill Road*
                                      *Holliston, Massachusetts  01746*
                                      *U.S.A.*

Type of Equipment:                    *Syringe Pump*

Model No.:                            *70-2204 (Microliter Pump Module)*

I, the undersigned, hereby declare that the equipment specified above
conforms to the above Directive(s) and Standard(s).

Place:                                *United States of America*

Date:                                 *September 06, 2002*

C E

HARVARD
A P P A R A T U S

_____
(Signature)

Beth Bauman
(Full Name)

VP Engineering / Operations
(Position)